PHOTOMETRIC PROPERTIES OF THE ICY SATELLITES OF JUPITER AND SATURN: RELATIONSHIP BETWEEN REGOLITH PROPERTIES AND THE OPPOSITION SURGE

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Observations from the Galileo and Cassini orbiters provide the first opportunity to observe the icy satellites of the outer solar system at a wide range of phase angles from the same observing platform. Of particular interest are observations made at very low phase angles where the shape of the phase curve is influenced by the opposition effect. Theoretical models relate the size and width of the opposition peak to physical properties of the regolith, principally the albedo, the particle size and the particle spacing. Our laboratory investigations find a qualitative agreement with the theoretical predictions but the size of the observed effects differs from theory by at least an order of magnitude.

We measured the phase curves from 0.05-5 degrees of a suite of well sorted aluminum oxide powders (Nelson et al, 1998). The particle sizes were $0.05<D<30$ microns. The samples were presented with linearly and circularly polarized light of wavelength 0.633 microns from a HeNe laser. We measured the intensity of the reflected light in both senses of linear and circular polarization. Our samples exhibit a pronounced increase in reflectance and an increase in circular polarization ratio with decreasing phase angle, consistent with a coherent backscattering induced opposition peak. This effect is observed in powders with particle sizes 50 times larger and 12 times smaller than the wavelength of the incident radiation.

The width of the opposition surge as a function of particle size is at least an order of magnitude larger than that observed in latex spheres in liquid suspension (Akkermans et al, 1986), indicating that other factors besides particle separation and index of refraction play an important role in the shape of the phase curve. Comparing the observed half width at half maximum with the predictions from the theoretical models of Mishchenko (1992) finds the HWHM of the observed opposition peaks to be an order of magnitude wider than theory predicts.

The discrepancy between the laboratory observations and theoretical predictions suggests that the application of the current theory to the available Galileo data set of the icy satellites is unreliable. It is anticipated that by the time Cassini returns similar observations of the satellites of the Saturnian system there will be a set of laboratory observations of sufficient size so as to enable the development of models that will place realistic constraints the regolith properties of the icy satellites.

This work conducted under grants from NASA's Planetary Geology and Geophysics program.

Akkermans, A. A. et al (1986). Phys Rev Letters, 56, 1471.
Mishchenko, M. I., (1992). Astrophys. and Space Sci, 194, 327.
Nelson, R. M. et al. Proc Lunar Planetary Sci Conf, 1998.